The University of Chicago

INDIVIDUAL DIFFERENCES IN ABILITY TO ALTERNATE ACTIVITIES

A PART OF THE DISSERTATION SUBMITTED TO THE FACULTY OF THE DIVISION OF THE BIOLOGICAL SCIENCES IN CANDIDACY FOR THE DEGREE OF THE DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

By
CLARA BURRI

Private Edition, Distributed by
THE UNIVERSITY OF CHICAGO LIBRARIES
CHICAGO, ILLINOIS

Offprinted from
THE JOURNAL OF GENERAL PSYCHOLOGY
Vol. X, No. 2, 1934

The University of Chicago

INDIVIDUAL DIFFERENCES IN ABILITY TO ALTERNATE ACTIVITIES

A PART OF THE DISSERTATION SUBMITTED TO THE FACULTY OF THE DIVISION OF THE BIOLOGICAL SCIENCES IN CANDIDACY FOR THE DEGREE OF THE DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

By
CLARA BURRI

R. UNIV.
BIBLIOTHEEK
LEIDEN

Private Edition, Distributed by
THE UNIVERSITY OF CHICAGO LIBRARIES
CHICAGO, ILLINOIS

Offprinted from
THE JOURNAL OF GENERAL PSYCHOLOGY
Vol. X, No. 2, 1934

INDIVIDUAL DIFFERENCES IN ABILITY TO ALTERNATE ACTIVITIES*[1]

From the Psychological Laboratory of the University of Chicago

CLARA BURRI

PROBLEM

The problem with which this study is concerned may be formulated as follows: The primary purpose of this experimental and statistical investigation is to find out whether people differ consistently in their ability to do varied as against constant tasks, and to what extent this ability to alternate is a function of the tasks and conditions. This question we attempted to answer by testing to see how the ability is influenced by such variables of the alternating situations as the kind of tasks; the condition of alternation, that is, whether alternation occurs between similar or dissimilar tasks; and the frequency of alternations. This last aspect has been merely touched upon in this study. A second objective of the study is to throw more light on the problem of whether individual differences in ability to alternate between tasks may be wholly due to the degree of perseverative activity, or whether some additional factors are present, and, if so, what kind. A third objective of the study is to see whether, on the average, continuous or alternating activity is more effective, and whether the average results remain constant from task to task.

METHOD AND PROCEDURE

Material and Subjects. The general method employed is that of individual experimentation in which simple tasks were performed singly and in alternation. Fifty-one undergraduate and graduate students from the University of Chicago were given four pairs of tests which had been selected to represent various degrees in similarity

*Recommended by A. G. Bills, accepted for publication by Carl Murchison of the Editorial Board, and received in the Editorial Office, June 27, 1933.

[1]A part of the dissertation submitted to the Faculty of the Division of the Biological Sciences in Candidacy for the Degree of Doctor of Philosophy in the Department of Psychology, University of Chicago.

of material and various differences in kinds of tasks. We also attempted to choose as nearly as possible, without interfering with the specific problem involved in this study, the same activities which have been used before in experimental studies of alternating activity. In the first pair of tests, the subjects had to work either continuously on simple addition or subtraction problems of two-place numbers or to shift from addition to subtraction every minute or every ten seconds. For the second test-pair the same procedure was employed, only this time the task was to write either adjectives or verbs as associative responses to a list of given nouns. These two sets of tests were selected to represent predominantly mental tasks, while the third set of tests was predominantly motor. It consisted in drawing triangles inside circles, continuously putting the point up or down, or alternating between the two methods. Finally, in the fourth test-pair the subjects were required to form S's or closed figures (⇳) from groups of six dots which had been placed together without definite arrangement. Those tests required perception of form or configuration. When the two figures are formed in alternation it not only indicates the ease with which a given individual can perceive one or another form from a group of patternless dots, but also his ability to change motor set.

Conditions. Three main conditions of work were used:

A. Continuous work
B. Alternation between two tasks, every minute
C. Alternation between two tasks, every ten seconds

The work material was combined into groups of similar and dissimilar tasks. The alternation activity of similar tasks was:

1. Additions—subtractions
2. Verbs to nouns—adjectives to nouns
3. Drawing triangles, point up—drawing triangles, point down
4. Forming closed figures—forming S's

The dissimilar tasks consisted of:

1. Subtractions—verbs to nouns
2. Additions—forming closed figures
3. Adjectives—drawing triangles, point down
4. Drawing triangles, point up—forming S's

Procedure. Every subject worked for eight minutes at a given

task either continuously on one task for the whole period or alternating between two tasks. During continuous work he had to draw a line after the last element finished whenever he heard the signal "check" given by the experimenter. This checking signal was given every minute, thus allowing an analysis of the amount of work performed during small intervals. When alternating work was done, a changing signal was given either every minute, or every ten seconds, depending upon the condition. When changing every minute the subject also made a check ten seconds after every change. This procedure gives a check on the immediate effect of changing.

In order to counterbalance practice effects every subject went through every test twice, first in normal and then in reversed order. As the final score the average amount of work from the two performances was used. The conditions were carried out in the following order:

A. Continuous work
1. Adding
2. Adjectives to nouns
3. Triangles, point up
4. Forming closed figures from groups of six dots
5. Subtracting
6. Verbs to nouns
7. Triangles, point down
8. Forming S's from groups of six dots

B. Alternating every minute
1. Similar tasks
   a. Subtracting—adding
   b. Adjectives to nouns—verbs to nouns
   c. Triangles, point up—triangles, point down
   d. Forming closed figures—forming S's
2. Dissimilar Tasks
   a. Subtracting—verbs to nouns
   b. Adding—forming closed figures
   c. Adjectives to nouns—triangles, point down
   d. Triangles, point up—forming S's from dots

C. Alternating every ten seconds

For this part of the investigation the same tests and order of procedure as for alternating every minute were used. Only six subjects participated in this condition.

After a subject finished this order, every test was repeated; but this time he started with the condition and tests finished at his last sitting and ended with continuous adding, the task which before he had performed first.

The various problems were presented on sheets of paper on which the subjects also wrote the answers with a soft pencil. In the construction of arithmetic and word tests care was taken that a given problem or work was not repeated. When changing between similar tasks, such as adding and subtracting, the work was done on one sheet, simply by changing from the process of adding to that of subtracting, or vice versa, when the signal was given to change. But when working on alternation of dissimilar material the subjects wrote on two sheets, side by side, one containing, let us say, subtractions; and the other, groups of dots. Under this condition the subjects worked first for a minute on one sheet and then for a minute on the other, thus going back and forth from sheet to sheet whenever a change of task was demanded. From the point of view of an ideal experimental procedure, the use of these two methods is not desirable, but, since in alternating from sheet to sheet some trial subjects took about the same length of time as they did to start working again on the same sheet, it was decided to keep one sheet wherever it was possible. By so doing, the scoring and keeping-track of the combinations was greatly simplified.

Each task was continued for eight minutes, during which time a subject worked either alternatingly or continuously. The score for one working period was the number of additions or figures or verbs, etc., produced in four minutes, because, in alternating, half of the working period is filled with doing one task and the other half with another similar or dissimilar task. Continuous work was kept up for eight minutes rather than for only four in order to equalize fatigue effects. The score from eight minutes of work was then simply divided by two to make it comparable with alternation scores. No use of errors was made.

Treatment of Data. In order to obtain comparable measures of efficiency in doing alternate versus continuous work, a measure which is not influenced by the total amount of work, the ratios between the results from the two ways of working were computed. Taking the results from the continuous tasks as a standard, a subject could obtain a plus or minus score for alternating work, depending

upon whether he accomplished more or less when alternating between two activities than when working continuously on one task. For example, if a subject has a score of +8 per cent for adding, that means that he did 8 per cent more work when he alternated adding with subtracting than when he only added. A minus score, let us say, —10 per cent for adding, means that, when alternating, 10 per cent less work was performed by the subject than when working continuously. Every subject received such a ratio for every activity, first, for every task when alternated with its similar task, such as adding—subtracting; adjectives—verbs; triangles, point up—triangles, point down; S—closed figure; and, second, for every task when alternated with a dissimilar task, such as subtracting—verbs; adding—closed figure; adjectives—triangles, point down; and S—triangles, point up. Thus, there are sixteen ratios for every subject. In order to see whether some consistent trend is present for all subjects and whether a general factor of alternating ability may be found for all the tests, the intercorrelations and tetrad differences were computed. A multiple-factor analysis was also made.

Results—For the Group as a Whole

Changing between Similar Tasks versus Continuous Performance. Did the subjects taken as a group work better when changing every minute from one to another similar task, or when working continuously on one task? Table 1 shows an answer to this question. It gives the average ratios from the pool of the eight tests. Thirty-eight of the 51 subjects obtained a positive average ratio from the eight tests, which means that, on the average, they worked better when alternating between two tasks than when working continuously on one task, while the remaining 13 subjects obtained a negative average ratio from the eight tasks, indicating that they did better on constant work. Considering the group as a whole, we obtain an average of 2.80 per cent in favor of alternation. This difference of not quite 3 per cent is not statistically significant, but since 38 of the 51 subjects are better at alternating than at continuous work it indicates a definite trend.

Although the pooled results of the group indicate only little advantage of alternation over continuous work, it is possible that if we study the results from the various tests separately this tendency may come out more clearly. Perhaps with some tasks one can

TABLE 1

AVERAGE OF RATIOS COMPARING ALTERNATING WITH CONTINUOUS PERFORMANCE ON EIGHT TESTS USING SIMILAR TASKS

Subjects	Average improvement alternating	P.E. of average
38 S's better alternating	5.82	±.468
13 S's better continuous	6.00	±.675
All subjects	2.80	±.769

achieve more when one is alternating between two similar activities while with another activity it may be better to work continuously in order to obtain maximal efficiency. Some light is thrown on this problem by Table 2.

TABLE 2

THE RATIOS BETWEEN PERFORMANCE ON CONTINUOUS AND ALTERNATING SIMILAR TASKS

Tasks (and tasks with which alternated)	Average ratios	P.E. of average	Sigma P.E.
Adding—(subtracting)	—1.25	± .97	10.30± .68
Subtracting—(adding)	—3.35	± .97	10.22± .68
Adjectives—(verbs)	1.80	±1.09	11.05± .77
Verbs—(adjectives)	2.05	±1.37	13.50± .87
Triangles, point up—(triangles, point down)	9.00	±1.56	16.50±1.09
Triangles, point down—(triangles, point up)	3.75	±1.09	11.50± .76
Closed figure—(S)	5.05	±1.10	12.00± .80
S—(closed figure)	6.20	±1.04	12.50± .82

Table 2 gives the average differences for each test separately. For six out of the eight tasks the group did better, on the average, when alternating. For addition and subtraction there is, however, a small difference in favor of continuous work. Although the average ratios of —1.25 per cent for addition and —3.35 per cent for subtraction are not statistically significant, it is nevertheless interesting to note that these results agree with those obtained and reported by Dashiell (*2a*). He too found that his subjects added better when they were permitted to complete one hundred problems continuously than when they were required to mix the additions with subtractions, divisions, and multiplications. It is possible that, when addition is alternated with subtraction, interference of specific responses occurs. This suggests the necessity of special explanatory factors adapted to particular situations. The group averages for the different tasks suggest that

perhaps the kind of task is a factor in determining whether a group of subjects is more efficient when alternating between two similar activities or when working continuously on one. There is a definite difference in degree of advantage from alternating work for the tests involving verbal material and those for motor activity, the latter being consistently larger.

TABLE 3

AVERAGE OF RATIOS COMPARING ALTERNATING WITH CONTINUOUS PERFORMANCE ON EIGHT TESTS USING DISSIMILAR TASKS

Subjects	Average improvement alternating	P.E. of average
47 S's better alternating	+10.65	± .63
4 S's better continuous	— 3.28	±1.11
All subjects	+ 9.55	±1.28

Changing between Dissimilar Tasks versus Continuous Performance. If our subjects alternate between two dissimilar tasks, such as addition and drawing a figure, we find that most subjects perform more work when they can alternate between tasks at intervals of one minute than when they have to work on one task for eight minutes at a stretch. On an average, 9.55 per cent more work was completed during a four-minute working period when the subjects alternated.

This superiority of alternating over continuous work may be seen even more clearly from Table 4, where the group averages are reported for each task separately. As far as these tasks are concerned, varied activity consistently brings about greater efficiency than does continuous activity.

In general, these group results agree with the findings of Wyatt (5, 6), Chapman (2), Robinson and Bills (4), Bills and McTeer (1), and others. These authors all found that people tend to work better when alternating, but that this superiority of alternation varies from task to task and from situation to situation, depending upon various factors. Those which are shown to have the greatest influence on the effect of alternation versus constant activity are: (1) the kind of the tasks to be alternated, whether arithmetic, or adjectives, or triangles; and (2) the similarity of the tasks, whether alternation occurred between two kinds of arithmetic, or between arithmetic and something else.

TABLE 4
THE RATIOS BETWEEN PERFORMANCE ON CONTINUOUS AND ALTERNATING DISSIMILAR TASKS

Tasks (and tasks with which alternated)	Average ratios	P.E. of average	Sigma	P.E
Adding—(closed figure)	10.54	±1.52	14.00	± .93
Subtracting—(verbs)	8.97	± .94	10.00	± .68
Adjectives—(triangles, point down)	11.42	±1.11	11.80	± .78
Verbs—(subtracting)	8.85	±1.45	15.40	±1.03
Triangles, point up—(S)	10.25	±1.56	16.50	±1.10
Triangles, point down—(adjectives)	3.77	±1.41	14.95	±1.00
Closed figure—(adding)	7.40	± .96	10.45	± .69
S—(triangles, point up)	17.40	±1.51	16.05	± .77

Individual Differences in Ability to Alternate. In this study interest is directed mainly to the problem of individual differences. Instead of studying merely group results, an attempt was made to find out whether a difference exists in ability to do varied as against constant tasks. If so, is this difference a consistent one, or does the ability to do alternating work vary from condition to condition? If it does vary, what are some of the factors that influence the ability? An attempt is made to answer these questions in the following part of this report.

Types of alternators. First let us see whether subjects can be arranged according to type. We have already shown that we did not find 100-per-cent consistency in our subjects' ability to alternate. With the exception of one subject the ability to alternate varied from task to task. Sometimes a subject worked better alternately between two tasks, at others continuously at one. However, when we calculated some sort of average performance score for each subject we found that the subjects showed a trend either for being better at alternation or at constant work.

Since no complete consistency in a person's ability to alternate could be found, the problem next arises of deciding on what basis to divide the group of subjects. This may be done in several ways, and the results will vary according to the criterion of classification. For the sake of convenience, let us classify a subject as a good or a poor alternator according to whether he did better one way or the other in more than half of the eight tests, and also according to whether his average score or ratio from the eight tests is negative or positive.

If such a classification is carried out regardless of the amount of difference between alternating and constant work, and regardless of the consistency in tendency from test to test, it is found that 37 subjects did better alternating regardless of the condition, 10 subjects were good alternators when the change occurred between dissimilar tasks, but not between similar tasks; while only 3 out of the 51 subjects did better on constant work regardless of the condition. One subject worked better when alternating similar tasks, while he did less well when alternating dissimilar tasks. However, in this last case the difference between the two conditions is so small that it can be neglected. Table 5 gives the average of ratios comparing continuous and alternating similar and dissimilar tasks for each of these groups, the poor and the good alternators.

TABLE 5

AVERAGE OF RATIOS COMPARING CONTINUOUS WITH ALTERNATING SIMILAR AND DISSIMILAR TASKS, FOR POOR AND GOOD ALTERNATORS

"Type"	Alternating	
	Similar tasks average ratios	Dissimilar tasks average ratios
1. Good alternators (37)	+5.9	+11.6
2. Good alternators in condition two, poor in condition one (10)	—5.5	+ 7.2
3. Poor alternators (3)	—6.1	— 4.2
4. Good alternator in condition one, poor in condition two (1)	+2.1	— 0.5

Although we showed in the above paragraph that some people tend to be good or poor alternators, the average ratios are insignificantly small. Furthermore, we must remember that this classification is only an approximate one. In order to show just how inconsistent these people were in their ability to alternate, we tabulated the number of times each task was performed better during alternation and the number of times each task was performed better during constant work. These figures are shown in Table 6.

The number of times each test came out in favor of alternation is much more frequent and consistent for continuous versus alternating dissimilar tasks than for continuous versus alternating similar tasks. Additions and subtractions in the test for alternation of similar tasks are the only ones which turned out more than half the time in favor

of constant work. If we remember, the group averages, too, show this same tendency.

TABLE 6

THE FREQUENCY WITH WHICH EACH TASK WAS PERFORMED BETTER ALTERNATING THAN CONTINUOUSLY, AND VICE VERSA

Task	Continuous *vs.* alternating similar tasks and dissimilar tasks			
	Continuous alternating	Alternating continuous	Continuous alternating	Alternating continuous
Adding	29	22	10	41
Subtracting	35	22	9	42
Adjectives	20	31	11	40
Verbs	25	26	14	37
Triangles, point up	15	36	14	37
Triangles, point down	18	33	21	30
Closed figure	14	37	10	41
S	16	35	8	43

The effect of the kind of task. In the previous analysis of the group results we found that in general the ability to alternate differed from task to task. We remember that by varying between two similar tasks the subjects proved to be slightly more efficient when performing addition and subtraction as constant rather than as alternating tasks. Although all the other tests gave results in favor of alternation, the degree of this advantage varied for different tests, and for the two conditions, similar and dissimilar alternated tasks. If the ease of shifting varies in general from task to task, how then does the task influence an individual's ability to alternate? Will different subjects who are more efficient on the average when doing varied as against constant work show an equal degree of efficiency for all the tests? Or will the degree of their ability to change vary from task to task? Or may it even be absent for some tasks but present for others? These same questions arise for poor alternators, subjects who are more efficient at constant work as compared with varied work. In order to determine the degree of consistency from task to task the intercorrelations for the various tests were computed. They are presented in Tables 7 and 8.

Most of the correlations are positive, even though rather small. For continuous versus alternating similar tasks the coefficients range from —.08 to +.64, with an average coefficient of .21. Only 6 of the 28 correlations are four or more times their P.E.'s. The table of intercorrelations for continuous versus alternating dissimilar tasks

shows in the main the same tendency. Here we have a range of coefficients from —.11 to +.72, with an average correlation of .17. Again only 6 of the 28 coefficients are statistically significant, being four or more times their P.E.'s. These intercorrelations furnish little evidence of a general ability to alternate tasks. According to these results, if a person does better when alternating on one test it cannot be assumed that he will also do better when alternating on another test.

TABLE 7

INTERCORRELATIONS FOR THE RATIOS BETWEEN CONTINUOUS AND ALTERNATING SIMILAR TASKS

	1	2	3	4	5	6	7	8
1. Adding	—							
2. Subtracting	.44	—						
3. Adjectives	.29	.03	—					
4. Verbs	.24	.16	.37	—				
5. Triangles, point up	.07	.22	.03	.03	—			
6. Triangles, point down	.19	.21	.02	.04	.64	—		
7. Closed figure	.09	.22	.10	.11	.28	.35	—	
8. S	—.08	.18	.15	.12	.34	.26	.55	—

TABLE 8

INTERCORRELATIONS FOR THE RATIOS BETWEEN CONTINUOUS AND ALTERNATING DISSIMILAR TASKS

	1	2	3	4	5	6	7	8
1. Adding	—							
2. Subtracting	.14	—						
3. Adjectives	.09	—.09	—					
4. Verbs	—.10	—.11	—.06	—				
5. Triangles, point up	.21	.23	—.07	.27	—			
6. Triangles, point down	.02	.29	.05	.01	.42	—		
7. Closed figure	.15	.30	.09	.09	.72	.25	—	
8. S	.02	.32	.27	.14	.63	.21	.42	—

By inspection it may be noticed that the interrelations from predominantly "motor" tasks show some consistency; they also give the highest coefficients. Further, there is also some slight consistency in relationship between these tests and subtraction, but not between them and addition or verbs or adjectives. Another group of correlations which might indicate some degree of relationship, but to a slighter degree than the others, are those from the predominantly "mental" tasks, from the groups of alternating similar activities. A

comparison of the two sets of intercorrelations from alternating similar versus constant activity and from alternating dissimilar versus constant activity indicates little consistency of relationship for the two conditions of alternation. Again, a comparison of the intercorrelations from the predominantly "motor" and "mental" tasks suggests the idea that different factors are operating in these two sets of correlations.

The relatively high correlation for the "motor" tasks in the case of dissimilar alternation may be due to similarity of movements in these activities. For example, the highest correlation, .72, is between drawing triangles (↓Δ) in the direction as indicated by the arrow, and drawing figures (↓⇧) where we find the same general direction of movements. The same similarity of movement was used in drawing triangles (↓Δ) and S's (↓S), and these tests give a correlation of .63. According to these results it seems that the similarity of the movements in the response may be an important factor in determining an individual's ability to change from task to task.

Is there a general factor of alternating ability? From the procedure employed above, i.e., merely inspecting the tables of intercorrelations, it cannot be said whether or not one general factor and some specific factors are sufficient to account for these intercorrelations. In order to detect whether or not a common factor is present, the Spearman two-factor analysis was made. The tetrad differences of the intercorrelations for continuous versus alternating similar tasks may be summarized as follows:

The average deviation of tetrads from zero = .0348
The theoretical P.E. =±.0395
The largest tetrad = .2669±.069
The largest tetrad is 3.8 times its P.E.

For continuous versus alternating dissimilar tasks the results are:

The average deviation of tetrads from zero =—.0470
The theoretical P.E. =±.0377
The largest tetrad =—.2654±.067
The largest tetrad is 3.95 times its P.E.

According to Spearman and Holzinger, if the tetrad differences are to be explained as chance variations from zero, the average tetrad difference should be the same size as the theoretical average probable

error.[2] Another way of testing whether the two-factor criterion is satisfied is by seeing whether half of the tetrad differences are larger and half of them smaller than the P.E. Still another summary test is to take the largest tetrad difference and compute its P.E. If this tetrad difference is less than two and one-half times its P.E., it may be considered as insignificant. If, however, this largest tetrad difference is significantly large, five or more times the P.E., or at least if it is too large to assure that the two-factor analysis holds, then some group factor or factors may be present.

Accordingly, our results may be interpreted as satisfying the two-factor theory. At least we may say that most of the tetrad differences would vanish, a fact which indicates that most of them are caused by chance variations from zero. However, at the extremes of the distributions of the tetrad differences there are a few which are fairly large, and which suggest, therefore, the possibility of some additional factors. Since as a whole the dispersions of the tetrad differences which were obtained compare very closely with those dispersions which would be expected if the differences varied from their theoretical zero by chance factor only, it may be concluded temporarily that one factor is sufficient to account for the observed intercorrelations. Since the variables were all tests of alternation, let us call this common factor *A*, or alternating factor.

Our next problem is to determine the relation of this common factor to any of our variables. The correlations between any one of the variables and the common factor may be determined by finding the interrelations of any three of the variables, by the formula $r_{kg}=\frac{rak \quad rbk}{rab}$. By this method we estimated the correlation between a given test for the condition alternation of similar tasks and the common factor. The results are:

	r_{kg}
Addition	.5203
Subtraction	.3797
Adjectives	.2656
Verbs	.4170
Triangles, point up	.4903
Triangles, point down,	.4806
Closed figure	.5631
S	.6950

[2]See formula 16 in Holzinger's (3) monograph on the tetrad-difference criterion.

The relationship of this common factor to the different tests varies from test to test. For subtraction and adjectives it is rather low; in fact, it is not present to any great extent anywhere except in the S-forming test.

The significance of this factor loading was estimated by the formula $\Sigma rkg^2/n$. The index of significance for the common factor is .2439, which indicates that, although a common factor is present, it is not very important in accounting for the intercorrelations for the condition alternating similar versus constant tasks. Presumably for the majority of these tests the specific factors are equally as important as, or even more important than, the common factor in accounting for the intercorrelations.

Because of these findings the question arose whether these tests could not be better described by several factors than by a single factor. Although Spearman's criterion is satisfied, it is entirely possible that some of these tests have something else in common. Therefore we proceeded to try a multiple-factor analysis.

A multiple-factor analysis. The technique for this multiple-factor analysis is the "simplified method" of Professor Thurstone.[3] Since the method is intricate and lengthy, a description of its application would be out of place here. Hence, we shall merely report the results.

By investigating our two sets of tests with a multiple-factor pattern it was discovered that each set has one conspicuous common factor running through all of the tests and that in addition each set had three other factors of more or less importance. The four factor loadings for the eight variables for the two sets of tests are as follows:

1. Continuous versus Alternating Similar Tasks

	k_1	k_2	k_3	k_4
Adding	.4278	.5353	—.2525	.1498
Subtracting	.4838	.2119	—.2725	.3728
Adjectives	.3436	.3803	.3782	—.1751
Verbs	.3820	.3803	.2857	—.1520
Triangles, point up	.5882	—.2913	—.2005	—.1912
Triangles, point down	.5984	—.2793	—.2835	—.1166
Closed figure	.5730	—.3163	.2262	.3048
S	.5271	—.3736	.3493	.2114
Index of significance $(\Sigma k^2/n)$ =	.2491	.1252	.0845	.0502

[3]The procedure for the application of this technique was obtained from a lecture on this subject, which will soon appear in print.

2. Continuous versus Alternating Dissimilar Tasks

	k_1	k_2	k_3	k_4
Adding	.1600	.0938	—.0801	—.1008
Subtracting	.4516	.2184	—.5140	.1286
Adjectives	—.0029	.7940	—.5252	.2480
Verbs	.1743	—.3055	.3725	.1994
Triangles, point up	.9349	—.0095	.3005	.1809
Triangles, point down	.4430	—.0386	—.1768	—.0237
Closed figure	.7316	.1232	.0365	.2019
S	.6002	.1892	.0993	.4642
Index of significance $(\Sigma k^2/n)$ =	.2782	.1052	.1020	.0543

These results indicate that the ability to alternate is considerably more complex than has hitherto been assumed. The nature of the factor loadings for condition alternating similar versus constant activity suggests that the first factor may be ability to alternate muscular set, and the second one possibly represents flexibility in symbolic processes. Its presence increases ability to alternate addition, subtraction, adjectives, and verbs, while it diminishes ability to alternate the more muscular activities. The third and fourth factors are of minor significance and have no clear interpretation. They do, however, indicate the presence of other variables which help determine ability to alternate.

The factor pattern from alternating dissimilar versus constant tasks shows the same general tendency as does that for alternating similar versus constant activities. Here, too, we find that there is one big factor which is common to all the tests, and three factors of less importance, two of which are of equal importance but less than the first, while the third one seems to be of only minor importance. It is somewhat difficult to interpret these factors. However, we may say that the first factor loading is again largest for the predominantly motor tasks.

Whatever we may decide regarding the nature of some of these details, we may at least draw a few conclusions about the findings as a whole, namely: Ability to alternate is very complex; there are at least several factors which determine whether an individual will work better alternatingly or continuously; for these results, four factors for each set of variables have been isolated. The most important of these factors, and the only one which has a clear rational

interpretation, seems to be in the nature of ability to change motor set. In the case of alternating similar tasks, there appears to be a second factor parallel to this first which may represent flexibility on the mental side.

The effect of various time intervals on ability to alternate. In order to see whether different lengths of time intervals between changes produce different effects on ability to alternate from task to task, six students worked the eight tests under two different conditions, at one time changing every minute and at another time every ten seconds. In Table 9 the average ratios between continuous activity and alternating between two similar and two dissimilar tasks every minute or every ten seconds are given for each subject and for the group.

TABLE 9

AVERAGE RATIOS BETWEEN CONTINUOUS AND ALTERNATING SIMILAR AND DISSIMILAR TASKS WITH CHANGE EVERY MINUTE AND EVERY TEN SECONDS

	Alternating			
	Every minute		Every ten seconds	
Subjects	Similar tasks ratio	Dissimilar tasks ratio	Similar tasks ratio	Dissimilar tasks ratio
1	—4.6	8.7	2.1	14.6
2	3.3	16.0	10.3	12.5
3	5.2	12.5	5.0	3.3
4	8.7	11.8	20.3	17.5
5	6.7	2.2	4.8	4.8
6	3.4	11.6	17.0	25.1
Averages	3.8	10.5	7.2	12.9

The general tendency of the results is the same when the change was made every ten seconds as when it was made every minute. The group averages are in favor of alternating for both conditions and both time intervals. Again, we find that the average difference between constant and variable work is greater for alternating dissimilar tasks than for similar tasks. This tendency exists when change occurred each minute and when it took place every ten seconds. When the subjects alternated every ten seconds they accomplished more than when they changed every minute. This is probably because they put more effort into their work; for when they alternated every ten seconds small enough work segments were produced so that they were able to keep track of their own accom-

plishment, and they tried to increase their speed throughout a work period. The reports indicated clearly that some of the subjects tried to do just a little more than usual. This special effort, rather than the time interval as such, may have caused the greater increase in efficiency for the condition alternating every ten seconds.

General Summary

In this investigation we have attempted to throw some light on the problem of ability to alternate activities in respect to these three considerations: first, whether individuals differ consistently in their ability to do varied as against constant work, and hence whether or not they may be considered either good or poor alternators; secondly, whether individual differences in ability to alternate may be considered as being due entirely to the degree of perseverative activity as certain investigators have assumed, or whether other factors are influential; and, thirdly, whether, on the average, continuous or alternating work is more effective.

1. In regard to our first problem we found that although people differ greatly in their ability to alternate activities they cannot be considered as good or poor alternators in a general sense. They show little consistency in their ability to do varied as against constant tasks. A given individual may be a good alternator in one situation and poor in another one. Ability to alternate was found to depend upon the type of the tasks alternated, whether arithmetic, association, or drawing triangles or figures, and upon whether the shift occurred between similar or between dissimilar tasks.

Even if we adopt a very loose criterion of "type," there seemed to be little tendency for a subject to be either a good or a poor alternator. When we tried to classify our subjects into poor and good alternating types on the basis of whether or not they did better alternating on at least four out of the eight tests and whether their final average performance was in favor of alternating or continuous work, we found that in alternating similar tasks 38 out of our 51 subjects worked better alternatingly and 13 worked better continuously, while for alternating dissimilar tasks 47 worked better, on the average, at alternation and only 4 at constant activity. Even according to this loose classification only four subjects can be regarded as poor alternators within the conditions of our experiment.

2. According to our results the problem of individual difference

in alternating activities is much more complex than has hitherto been assumed by those investigators who have attributed it wholly to differences in degree of perseverative activity. Our experimental findings agree with the conclusions reached in our analytical study,[4] in which we showed that, although "perseveration" may contribute to whether or not an individual is a good alternator, it is by no means the only, nor even the principal, causal factor.

By the application of the method of multiple-factor analysis to our data we isolated four factors for each of our two sets of alternating conditions (similar and dissimilar tasks). Each set has one conspicuous common factor and three other factors of more or less importance. The nature of the factor loadings suggests that the leading ones may be ability to change a general motor set and flexibility in alternating symbolic material.

3. On the average, our subjects worked better at alternating than at continuous tasks in the case of both similar and dissimilar tasks. However, the superiority of alternation depends in part upon the particular tasks. For example, for arithmetic tests our subjects gave an average performance in favor of continuous activity. The degree of superiority of alternation was influenced by the degree of similarity of the alternated tasks. If alternation took place between dissimilar tasks, the group, on the average, did 9.55 per cent better when alternating than when working continuously, while for alternating similar tasks it was only 2.80 per cent better.

Varying the frequency of alternation from one minute to ten seconds produces little difference in results for alternation versus constant activity. The advantage of alternating work is even greater when alternation takes place every ten seconds than when it takes place every minute.

References

1. Bills, A. G., & McTeer, W. Transfer of fatigue and identical elements. *J. Exper. Psychol.*, 1932, **15**, 23-36.

2. Chapman, J. G. The effect of rapid change of work on the rate of performance. *J. Exper. Psychol.*, 1917, **3**, 165-170.

2*a*. Dashiell, J. F. Fundamentals of psychology. New York: Macmillan, 1920. (See esp. Chap. 10.)

[4] A critical review of the "present status of individual differences in alternating activities" to be published in the *Psychological Bulletin.*

3. Holzinger, H. S. Statistical résumé of the Spearman two-factor theory. Chicago: Univ. Chicago Press, 1930. Pp. 43.
4. Robinson, E. S., & Bills, A. G. Two factors in the work decrement. *J. Exper. Psychol.*, 1926, **9**, 415-443.
5. Wyatt, S. The effect of change in activity. (*Indus. Fatigue Res. Bd. Rep.*, No. 26.) London: H. M. Stationery Office, 1924. Pp. 13-37.
6. Wyatt, S., & Fraser, J. A. The comparative effects of variety and uniformity in work. (*Indus. Fatigue Res. Bd. Rep.*, No. 52.) London: H. M. Stationery Office, 1928. Pp. iii+30.

c/o Ernest Bauman
North Adams, Michigan

LES DIFFÉRENCES INDIVIDUELLES DANS LA CAPACITÉ D'ALTERNER LES ACTIVITÉS

(Résumé)

Cinquante-et-un étudiants universitaires ont fait un travail continu d'addition, de soustraction, de placer un verbe ou un adjectif avec un substantif, de dessiner des triangles de forme ordinaire ou renversée, de former deux sortes de figures en employant des groupes de six points, et ensuite ils ont alterné entre deux de ces activités, telles que l'addition et la soustraction, ou l'addition et le dessin des triangles. Il y a eu quatre paires d'activités semblables et quatre paires de dissemblables. On a testé deux fréquences de changement en faisant alterner les sujets une fois par minute ou dix secondes. On a constaté de grandes différences individuelles dans la capacité d'alterner les activités mais très peu de constance entre les tâches. On ne peut considérer que nos sujets alternent bien ou mal dans un sens général. Ils montrent très peu de constance dans leur capacité de faire des tâches variées comparées aux tâches constantes. Un sujet donné peut bien alterner dans une situation et mal alterner dans une autre. On a constaté que la capacité d'alterner dépend du type des tâches alternées et aussi il faut considérer si le changement a eu lieu entre des tâches semblables ou des dissemblables. Même en adoptant un critère peu précis de type, on a observé que les sujets ne tendent que très peu à bien alterner ou à mal alterner. En alternant des tâches semblables 38 sur 51 sujets ont mieux travaillé continûment; tandis qu'avec des tâches dissemblables 47 ont mieux alterné avec une activité alternante et seulement quatre avec une activité constant. La variation de la fréquence de l'alternation d'une minute à dix secondes a produit peu de différence dans les résultats pour l'activité alternante et pour l'activité constante.

Burri

INDIVIDUELLE UNTERSCHIEDE IN BEZUG AUF DIE FÄHIGKEIT, TÄTIGKEITEN ABZUWECHSELN

(Referat)

Es arbeiteten 50 Studenten beständig mit Addition, Subtraktion, Hinzufügung von Zeitwörtern oder Eigenschaftswörten an Hauptworter, Zeichnen von Dreiecken mit der Spitze nach oben oder nach unten, und Bildung von zwei Arten von Gestalten aus Gruppen bestehend aus je sechs Punkten. Dann wechselten die Vpp. zwischen zwei dieser Tätigkeiten ab—zum Beispiel, zwischen Addition und Subtraktion oder zwischen Addition und Dreieckzeichnen. Es gab vier Paare ähnlicher und vier Paar nicht-ähnlicher Tätigkeiten. Es wurden zwei Abwechslungsschnelligkeiten dadurch versucht, dass man die Vpp. in manchen Versuchen jede Minute und in anderen alle zehn Sekunden abwechseln lies. Es zeigte sich, dass Vpp. in ihrer Fähigkeit, Tätigkeiten abzuwechseln stark verschieden sind, obwohl sie von Versuch zu Versuch nur wenig Beständigkeit in Bezug auf diese Fähigkeit aufweisen. Die einzelnen Vpp. liessen sich nicht als im Algemeinen "gute" oder "schlechte Abwechsler" [good or poor alternators] beschreiben. Sie erwiesen nur wenig Beständigkeit in ihrer Fähigkeit, abwechselnde im Vergleich mit konstantbleibenden Arbeiten auszuführen. Eine gegebene Vp. kann sich in einer Situation als ein "guter Abwechsler" und in einer anderen Situation als ein "schlechter Abwechsler" darstellen. Man fand, dass die Fähigkeit, abzuwechseln, einerseits von der Art der abgewechselten Tätigkeiten abhängig war, und anderseits davon, ob die Abwechslung zwischen ähnlichen oder zwischen night-ähnlichen Tätigkeiten stattfand. Auch dann, wenn man einen sehr allgemeinen Massstab der Abwechslungsfähigkeit anwendete, erwies sich die Tendenz der einzelnen Vp., sichs als guten oder als schlechten Abwechsler zu zeigen, als sehr gering. Bei der Abwechslung zwischen ähnlichen Tätigkeiten arbeiteten 38 der 51 Vpp. besser ununterbrochen. Bei der Abwechslung zwischen nicht-ähnlichen Tätigkeiten arbeiteten 47 unter Abwechslung besser, und nur 4 besser ununterbrochen. Eine Änderung der Häufigkeit von einer Minute auf 10 Sekunden bewirkt nur wenig Unterschied in den Befunden in Bezug auf abwechselnde und beständige Tätigkeit.

BURRI